Copy
RM L9K22

NACA RM L9K22

CLASSIFICATION CHANGED
~~confidential~~
change order #507
Date

RESEARCH MEMORANDUM

RESULTS OBTAINED DURING FLIGHTS 1 TO 6 OF THE NORTHROP X-4 AIRPLANE (A.F. NO. 46-677)

By James T. Matthews, Jr.

Langley Aeronautical Laboratory
Langley Air Force Base, Va.

CLASSIFICATION CHANGED
TO Unclassified
BY AUTHORITY OF #2484 Date 9-9-54

TECHNICAL EDITING WAIVED

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON

January 12, 1950

5/0-76

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

RESULTS OBTAINED DURING FLIGHTS 1 TO 6 OF THE NORTHROP X-4 AIRPLANE (A.F. NO. 46-677)

By James T. Matthews, Jr.

SUMMARY

NACA instruments were installed in the Northrop X-4 number 2 airplane (A.F. No. 46-677) to obtain stability and control data during the acceptance tests conducted by the Northrop Company. The results of flights 1 to 6 are presented in this report. These data were obtained for a center-of-gravity position of about 19.5 to 20.0 percent of the mean aerodynamic chord.

The data presented include a time history of a complete pull-up, time histories of several level and accelerated flight runs, and the effect of dive-brake extension on the longitudinal and lateral trim.

The pilot reports the mechanical trim device to be unsatisfactory for any stick-free or dynamic stability and control analysis because the stick force cannot be trimmed to zero sufficiently well to permit the stick to be released during a manuever without the airplane performing a divergence. In addition, the trim device is inoperative when more than 8.0° up elevon angle is required for trim. A short-period longitudinal oscillation with relatively poor damping was present, but this oscillation was not objectionable to the pilot. The airplane has a stable variation of longitudinal-control angle with normal-force coefficient for the indicated airspeed ranges of 180 to 300 miles per hour at about 30,000-foot pressure altitude.

Extension of the dive brakes up to ±30° has no appreciable effect on the longitudinal trim at indicated airspeeds of 160 miles per hour with landing gear down, and at airspeeds of 300 miles per hour with the landing gear up, at altitudes of 8,500 and 10,000 feet, respectively. A slight tendency to roll to the left was indicated in the landing-gear-down case.

LIBRARY NACA - HSFRS

INTRODUCTION

As a part of the Air Force-Navy-NACA transonic-flight-research program, the Northrop Company has constructed airplanes of the X-4 type. These airplanes were designed for flight research on a semitailless configuration at high-subsonic speeds.

NACA recording instruments have been installed in two X-4 airplanes to provide data for a stability and control analysis during the acceptance tests conducted by the Northrop Company. The present report presents data obtained during flights 1 to 6 for the second airplane (A.F. No. 46-677). Previous data obtained from the first airplane (A.F. No. 46-676) are presented in references 1 to 4.

SYMBOLS

V_i indicated airspeed, miles per hour

δ_e elevon angle, degrees

δ_r rudder angle, degrees

$\frac{\delta_{e_L} + \delta_{e_R}}{2}$ longitudinal-control angle, degrees

$\delta_{e_R} - \delta_{e_L}$ lateral-control angle, degrees

Subscripts:

L left elevon

R right elevon

AIRPLANE

The Northrop X-4 airplane is a semitailless research airplane having a vertical tail but no horizontal tail surfaces. It is powered by two Westinghouse J-30-WE-7-9 engines and is designed for flight research in the high-subsonic speed range. Photographs of the airplane are presented in figure 1 and a three-view drawing in figure 2. Table I lists the physical characteristics of the airplane.

TEST INSTRUMENTATION

The second Northrop X-4 airplane (A.F. No. 46-677) has more complete instrumentation than the first airplane because no structural or engine-temperature measurements are being made by the Northrop Company. Standard NACA internal instruments record altitude, airspeed, angle of sideslip, right and left elevon position, rudder position, right and left elevon hinge moments, rudder hinge moments, stick force, rolling and yawing velocities, and the three components of acceleration. In addition, the following quantities are telemetered to a ground station: normal acceleration, right and left elevon position, rudder position, airspeed, and altitude. All the internal records are correlated by a common timer. The telemeter and internal records are synchronized through the data switch in the cockpit.

The recording airspeed and altimeter are connected to the airspeed head on the vertical fin. A calibration of this installation has not yet been made.

RESULTS AND DISCUSSION

The results presented are for a center-of-gravity location at about 19.5 to 20 percent of the mean aerodynamic chord. Figure 3 presents a time history from flight 1 of a complete pull-up to about 2g. During the pull-ups of flight 3, shown in figure 4, the pilot took records only after the desired normal acceleration was attained. It is not known whether the stick force was trimmed to zero in level flight before these pull-ups. In the pull-ups of flight 5, shown in figure 5, short records were taken during the level-flight portion also.

Figure 5, run 2, shows a poorly damped short-period longitudinal oscillation in the clean condition at an indicated airspeed of about 265 miles per hour and a pressure altitude of about 31,000 feet. Although the damping is poorer than the damping normally associated with a conventional airplane, no objection to the oscillations were mentioned by the pilot. An indication that the stick-fixed longitudinal stability is positive in the clean condition may be obtained from figure 5. This figure shows that an increase in normal acceleration and consequently the normal-force coefficient requires an increase in the amount of up eleven control required at each indicated airspeed shown from 180 to 300 miles per hour at approximately 31,000-foot pressure altitude.

Figure 6 shows that extension of the dive-brakes up to ±30° at indicated airspeeds of 160 miles per hour, landing gear down, and 300 miles per hour, landing gear up, at pressure altitudes of 8,500 feet and 10,000 feet, respectively, has no appreciable effect on the longitudinal trim. The airplane, however, has a tendency to roll to the left when the landing gear is down. The dive-brakes are of the split-flap type, the lower flap being used as a landing flap. When the flaps are used as dive-brakes, they extend ±60°.

Figure 7 illustrates a typical landing approach and landing of the X-4 airplane. The indicated airspeed at contact was about 134 miles per hour and the normal-force coefficient of the airplanes was about 0.76.

The pilot's comments indicate that the present trim device is unsatisfactory for making a complete stability and control analysis. The pilot reports that the trim device is effective in trimming out large stick forces, but it is too sensitive for the relatively small remaining stick force to be trimmed to zero, consequently the stick cannot be released in maneuvers without the airplane's performing a divergence. Investigation of the mechanics of the trim device show it to be inoperative when more than 8.0° up elevon angle is required for trim.

CONCLUSIONS

Data obtained during flights 1 to 6 of the Northrop X-4 number 2 airplane (A.F. No. 46-677) indicate that:

1. The mechanical trim device was considered unsatisfactory for any stick-free or dynamic stability and control analysis because the stick force could not be trimmed to zero sufficiently well to keep the airplane from performing a divergence when the stick is released during a manuever.

2. The airplane had a short-period longitudinal oscillation with relatively poor damping at a pressure altitude of about 31,000 feet. This oscillation was not objectionable to the pilot.

3. The airplane had a stable variation of longitudinal-control angle with airplane normal-force coefficient at values of indicated airspeed between 180 and 300 miles per hour at about 30,000-foot pressure altitude.

4. Extension of the dive-brakes up to $\pm 30^{\circ}$ had no appreciable effect on the longitudinal trim but caused a slight tendency to roll to the left at 160 miles per hour when the landing gear was down.

Langley Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Air Force Base, Va.

REFERENCES

1. Drake, Hubert M.: Stability and Control Data Obtained from First Flight of X-4 Airplane. NACA RM L9A31, 1949.

2. Williams, Walter C.: Results Obtained from Second Flight of X-4 Airplane (A.F. No. 46-676). NACA RM L9F21, 1949.

3. Williams, Walter C.: Results Obtained from Third Flight of the X-4 Airplane. NACA RM L9G20a, 1949.

4. Valentine, George M.: Stability and Control Data Obtained from Fourth and Fifth Flights of the X-4 Airplane (A.F. No. 46-676). NACA RM L9G25a, 1949.

TABLE I

PHYSICAL CHARACTERISTICS OF THE NORTHROP X-4 AIRPLANE

Engines (two)	Westinghouse J-30-WE-7-9
Rating (each)	1600-pound static thrust at sea level
Weight for acceptance tests:	
Maximum (238 gal. fuel)	7786
Minimum (10 gal. fuel trapped)	6406
Wing loading, lb/sq ft:	
Maximum	38.9
Minimum	32.0
Center-of-gravity travel, percent M.A.C.:	
Gear down, full load	22.5
Gear down, empty	20.2
Gear up, full load	22.0
Gear up, empty	19.7
Height, over-all, ft	14.83
Length, over-all, ft	23.25
Wing:	
Area, sq ft	200
Span, ft	26.83
Airfoil section	NACA 0010-64
Mean aerodynamic chord, ft	7.81
Aspect ratio	3.6
Root chord, ft	10.25
Tip chord, ft	4.67
Taper ratio	2.2:1
Sweepback (leading edge), deg	41.57
Dihedral (chord plane), deg	0
Wing flaps (split):	
Area, sq ft	16.7
Span, ft	8.92
Chord, percent wing chord	25
Travel, deg	30
Dive-brake dimensions	Same as flaps
Travel, deg	±60

TABLE I - Concluded

PHYSICAL CHARACTERISTICS OF THE NORTHROP X-4 AIRPLANE - Concluded

Elevons:	
Area (total), sq ft	17.20
Span (two elevons), ft	15.45
Chord, percent wing chord	20
Movement, deg:	
Up	35
Down	25
Operation	Hydraulic
Vertical tail:	
Area, sq ft	16
Height, ft	5.96
Rudder:	
Area, sq ft	4.1
Span, ft	4.3
Travel, deg	30
Operation	Mechanical

SECRET

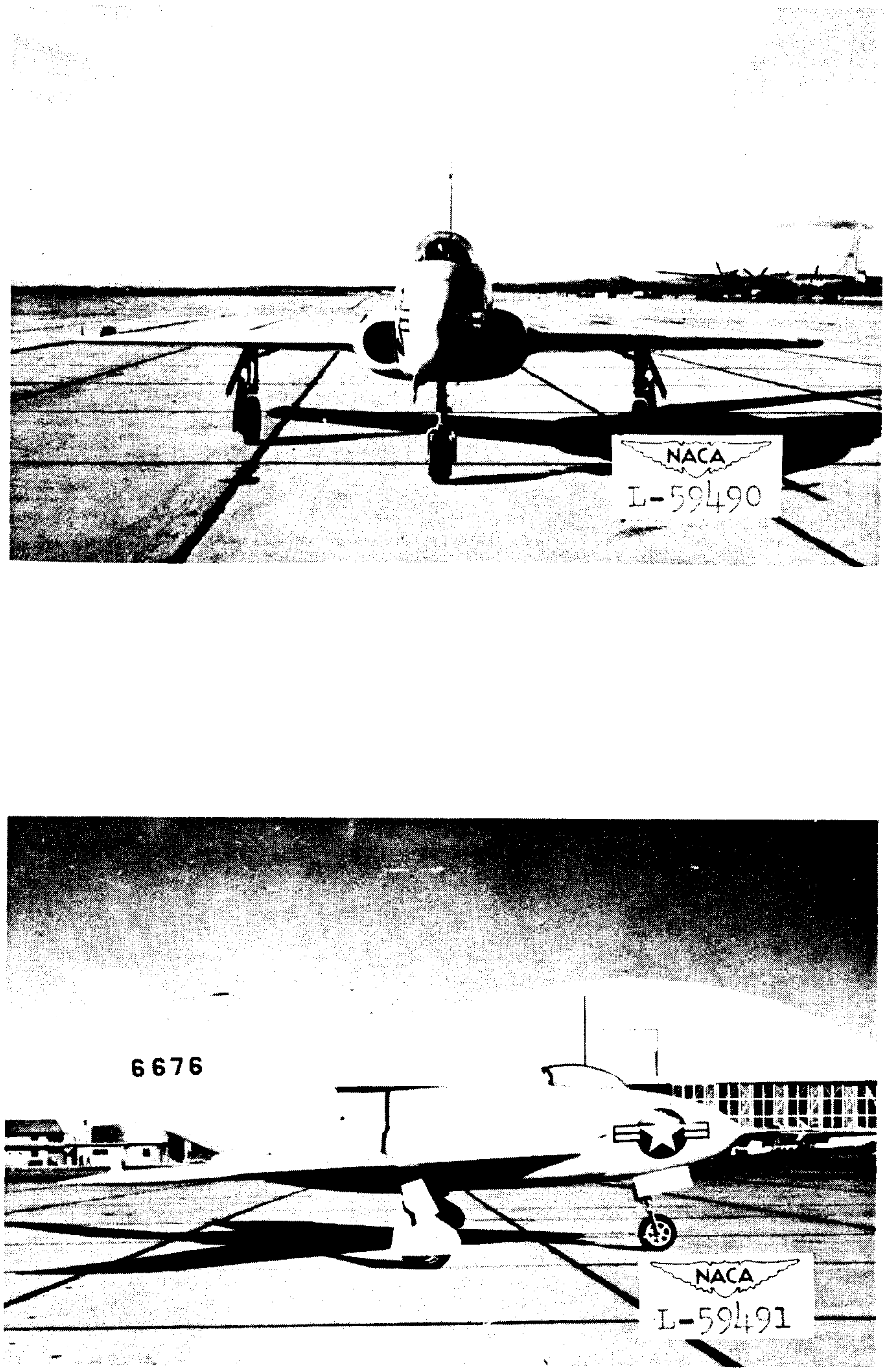
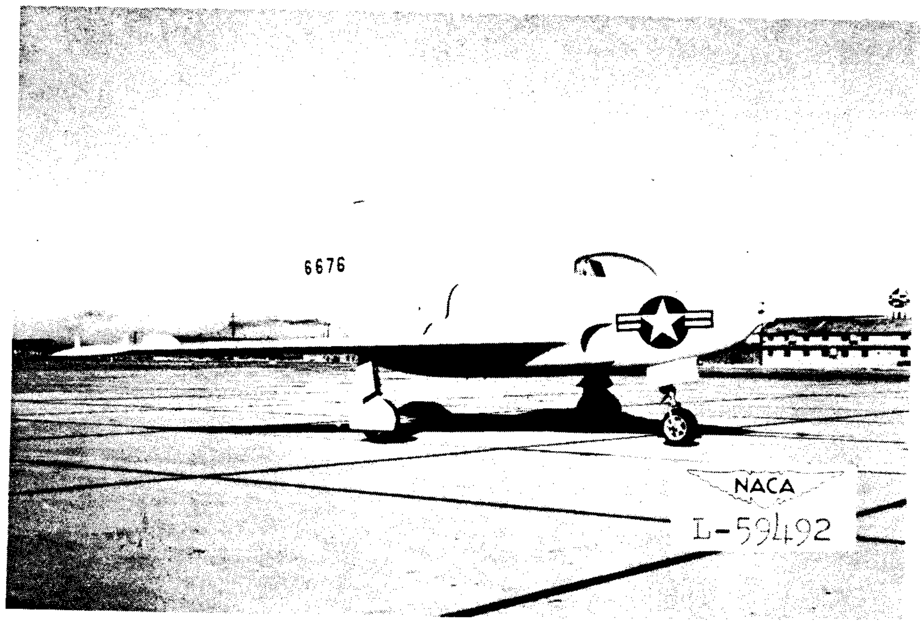


Figure 1.- Photograph of Northrop X-4 airplane.

SECRET

SECRET



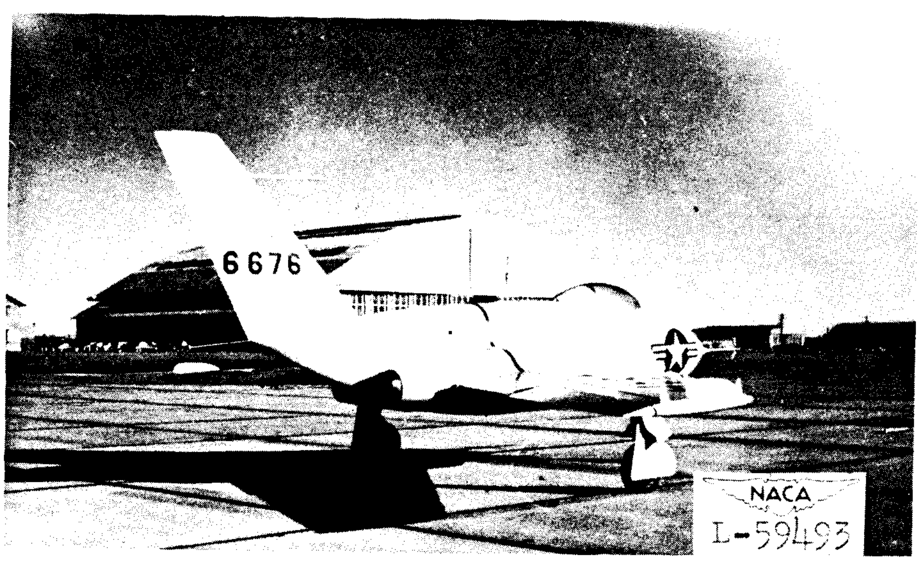


Figure 1.- Concluded.

SECRET

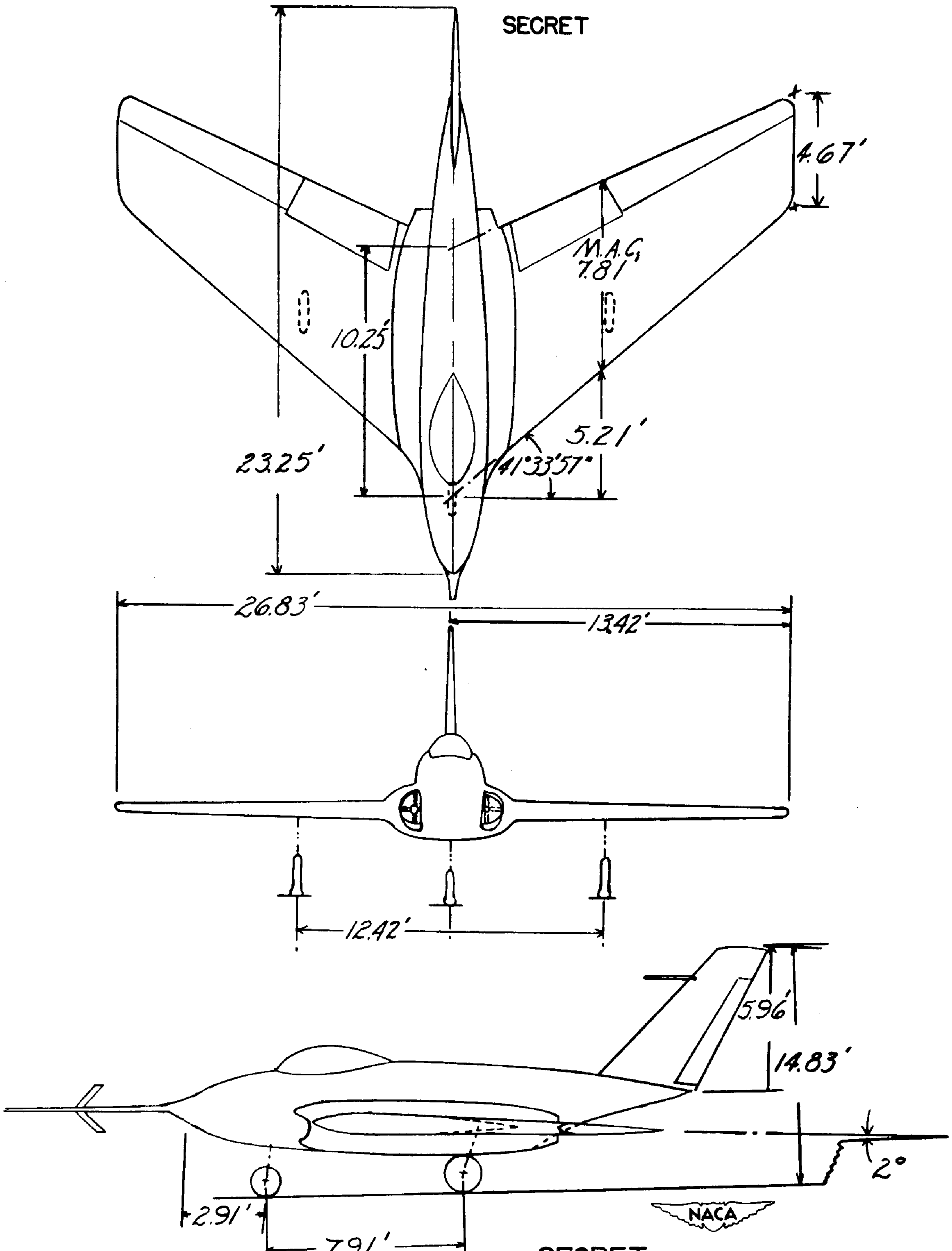


Figure 2.- Three-view drawing of the Northrop X-4 airplane.

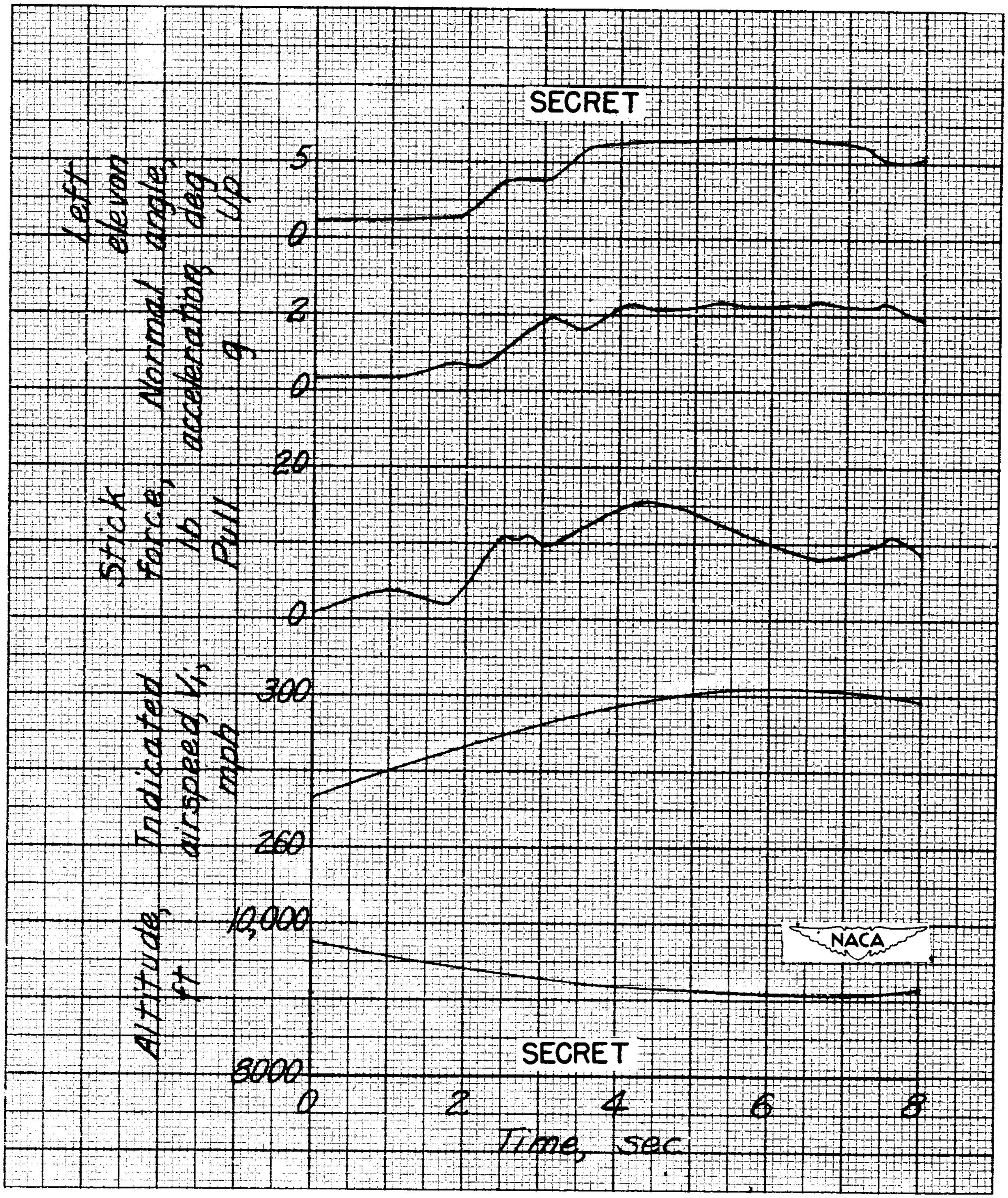


Figure 3.- Time history of a 2g pull-up for Northrop X-4 airplane (A.F. No. 46-677). Flight 1.

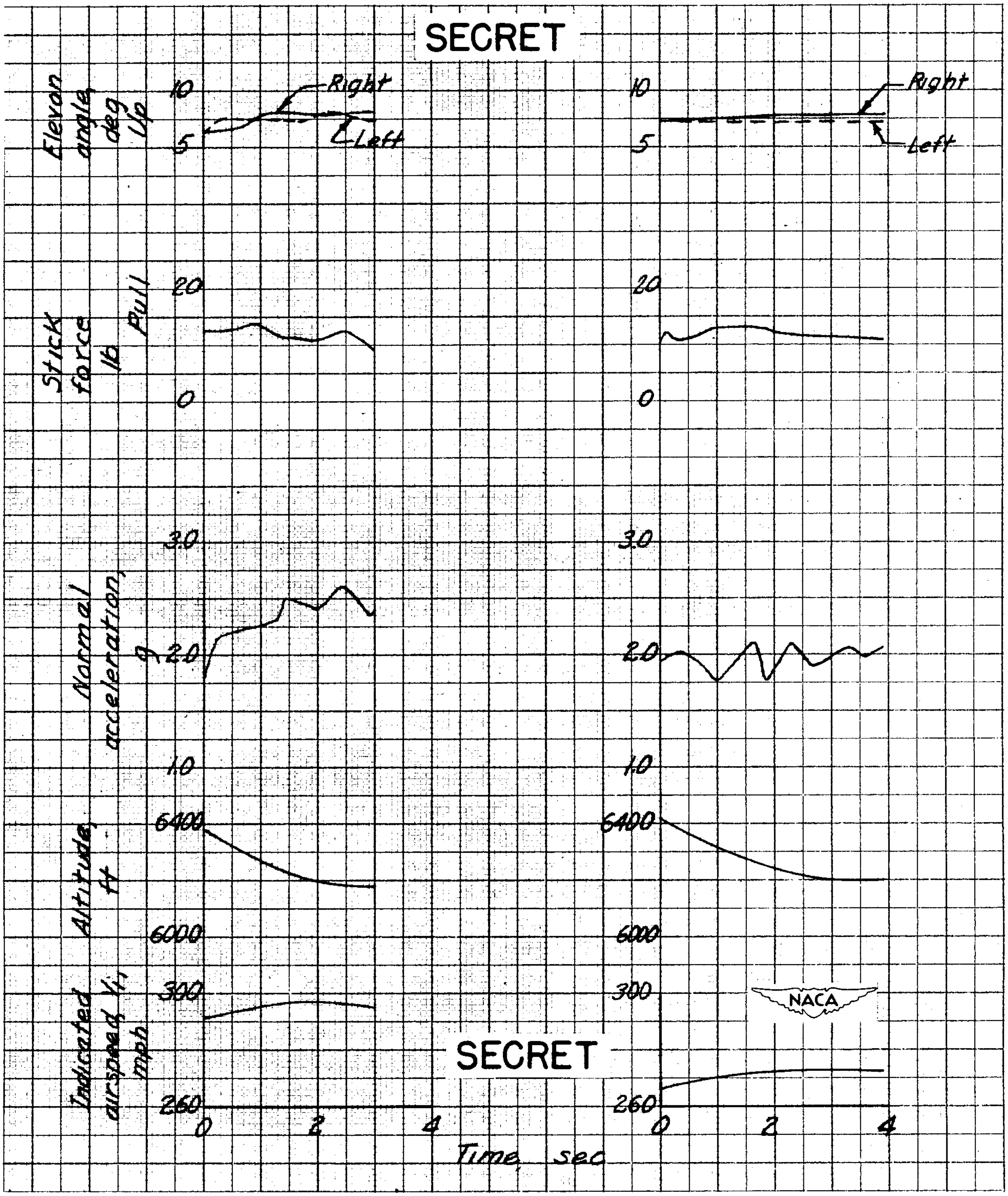
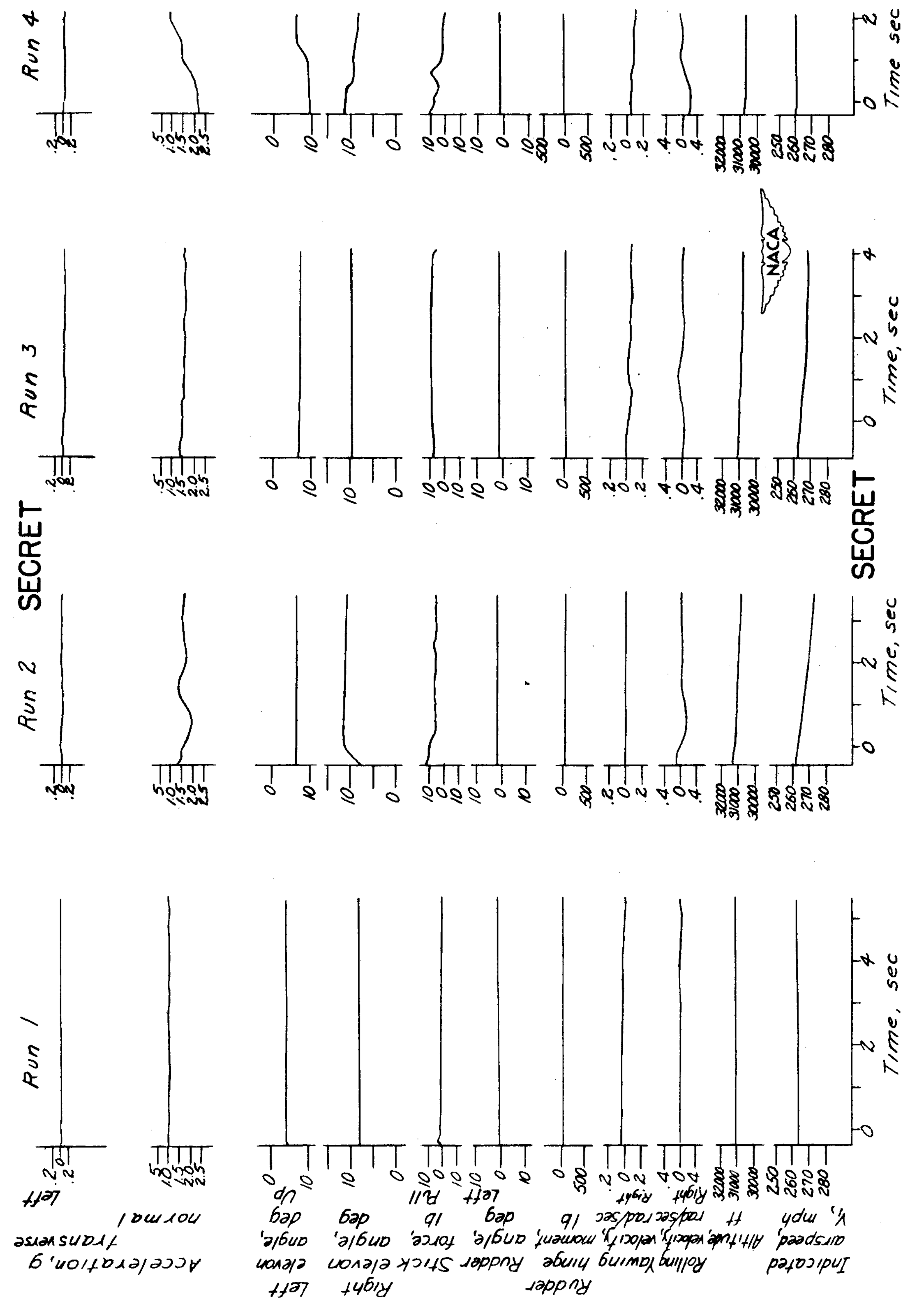


Figure 4.- Time history of measured quantities during accelerated flight of Northrop X-4 airplane (A.F. No. 46-677). Flight 3.

SECRET



SECRET

Figure 5.- Time history of measured quantities during level flight and accelerated flight of X-4 airplane (A.F. No. 46-677). Flight 5.

SECRET

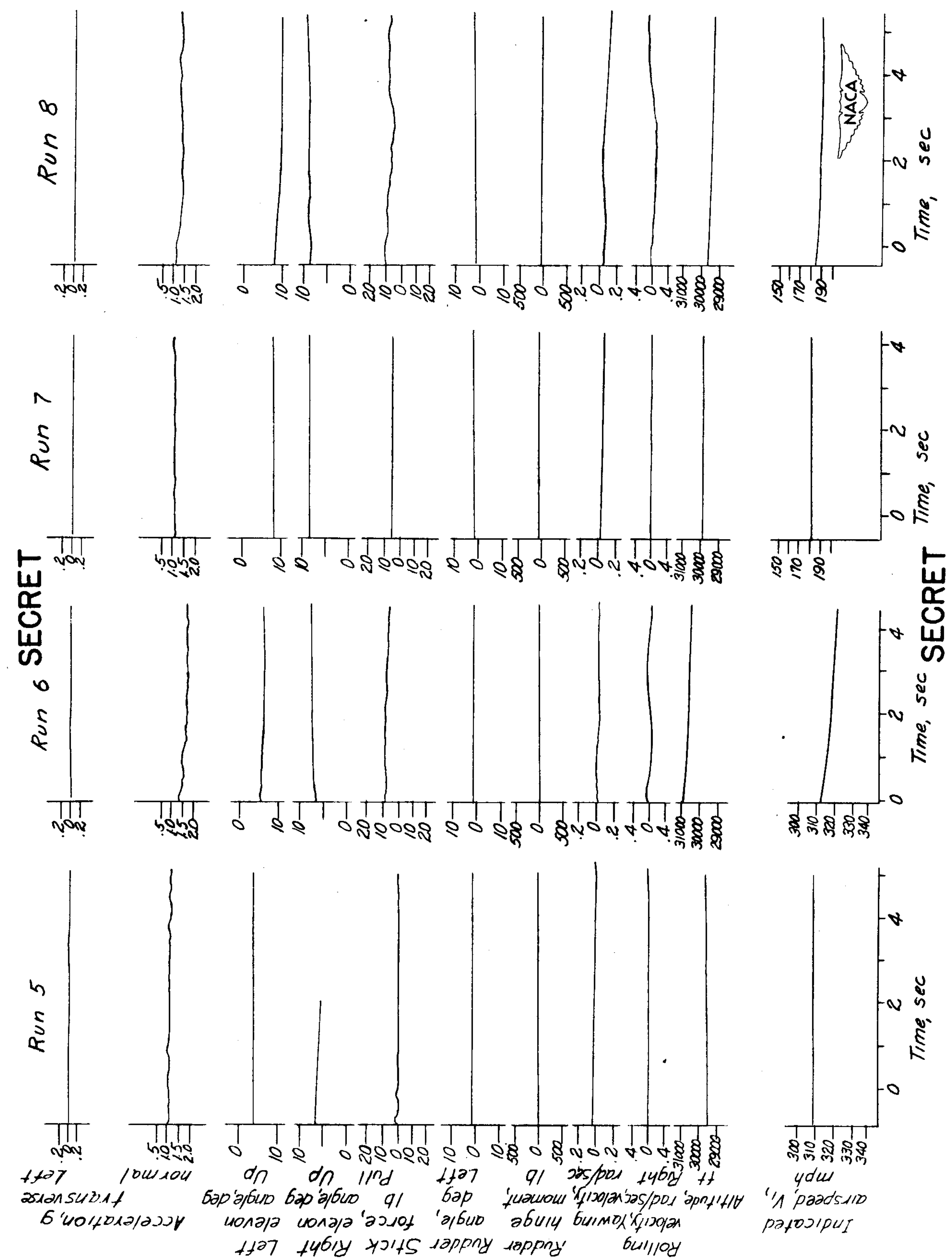


Figure 5.- Concluded.

SECRET

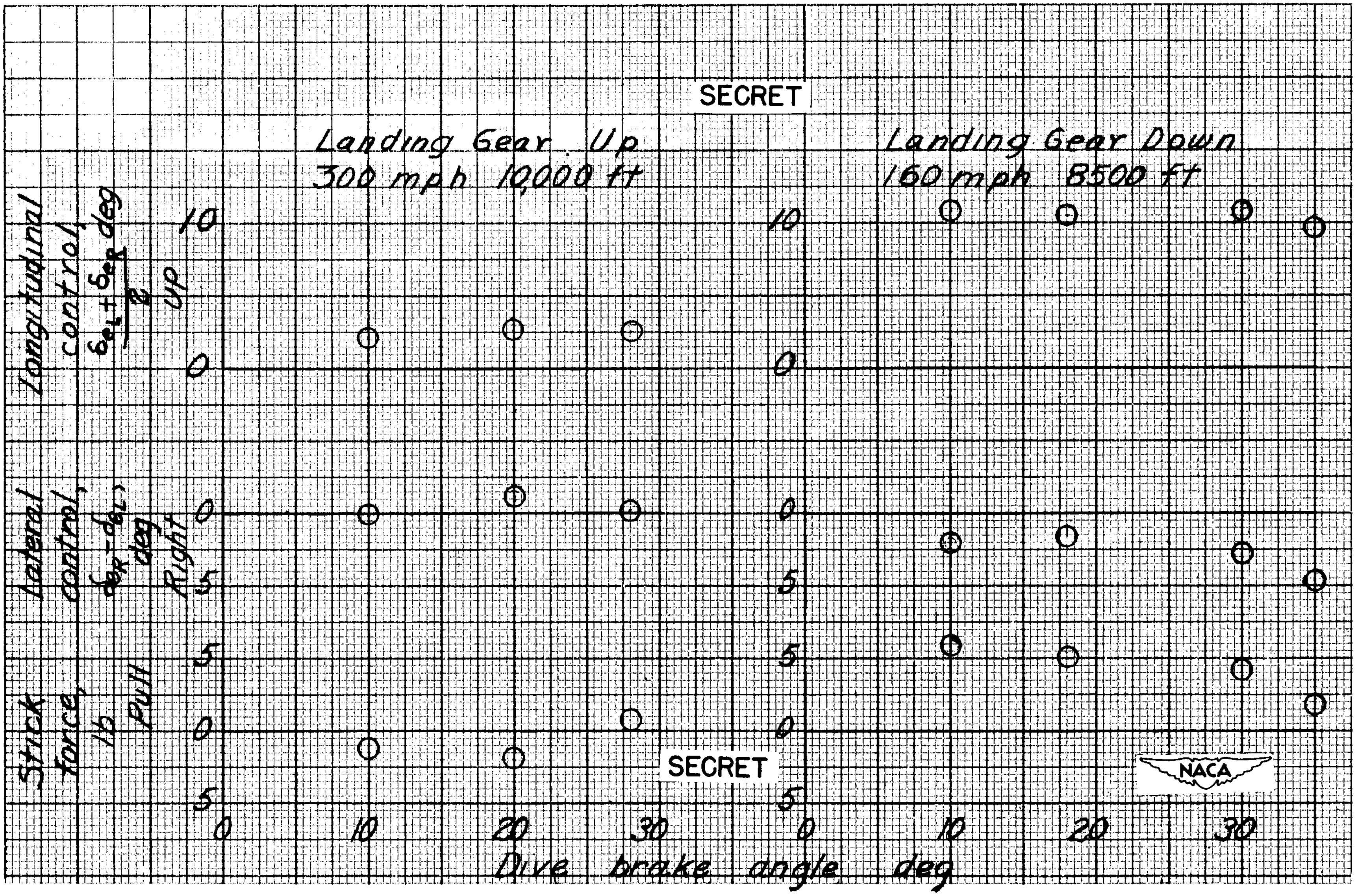


Figure 6.- Variation with dive-brake angle of longitudinal and lateral control and stick force of Northrop X-4 airplane (A.F. No. 46-677). Flight 4.

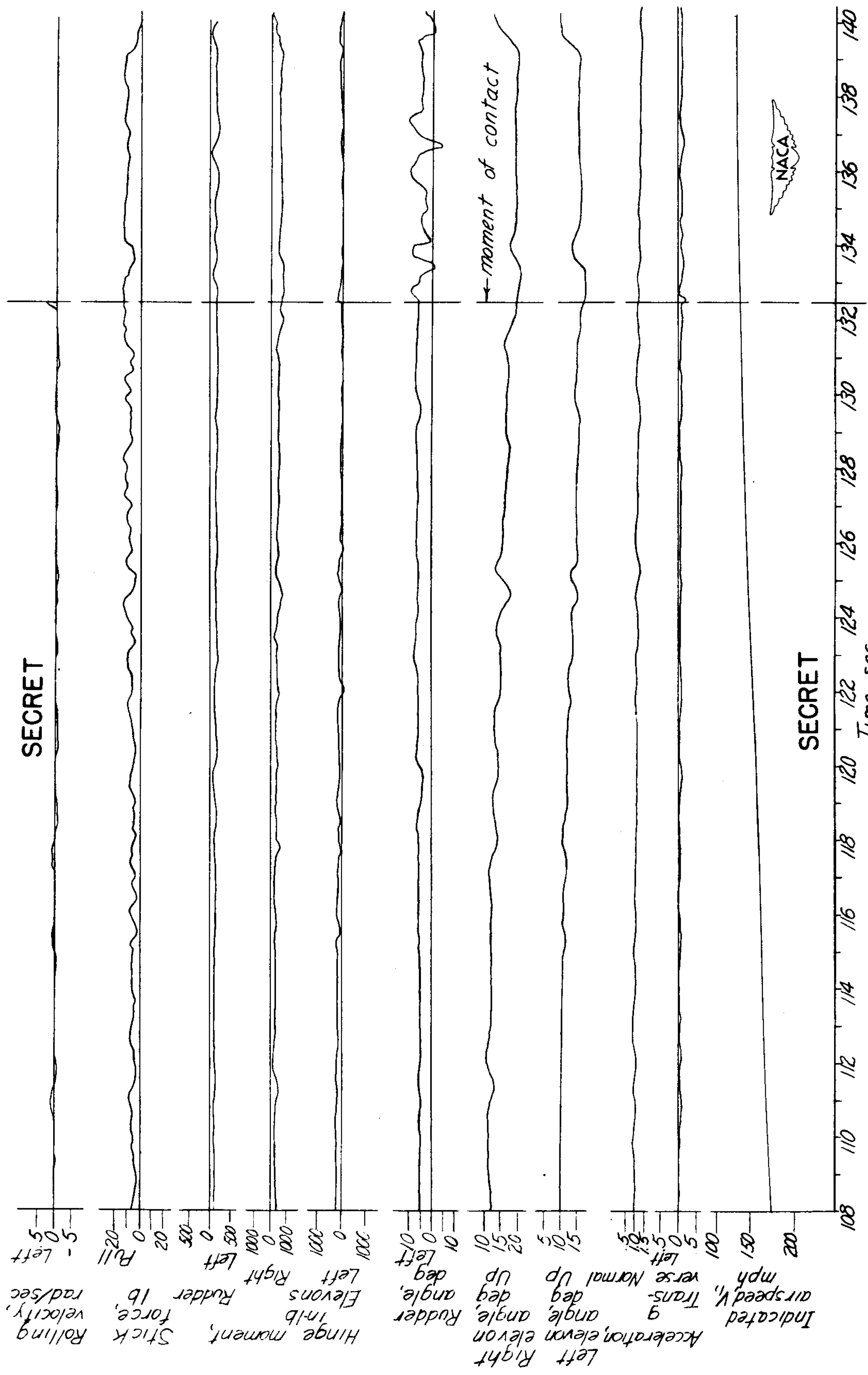


Figure 7.- Time history of landing approach and landing of Northrop X-4 airplane (A.F. No. 46-677) Flight 3.